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THE USE OF WATER METERS[1]

BY J. C. BEARDSLEY

Should all taps be metered? As a general proposition, no one will take issue with the statement that a measured rate is more just, more economical from the standpoint of both buyer and seller and more scientific, than any flat rate that can be devised. There may be apparently exceptional conditions, as in the Allegheny Mountain region or in the artesian well section of the Dakotas, where water is brought into the distribution mains under pressure, without pumping and therefor at low cost. Towns in these sections are usually small, with no very large consumers or considerable inequalities in consumption, so that flat rates do not work any great injustice; and the cost of water at the tap is perhaps negligible, while the cost of meters looms large in the eyes of the great majority of town legislators of those regions.

Even in these sections, however, some towns have drawn so heavily on their stored wealth of water that they have seen its exhaustion approaching and have resorted to meters, usually for all taps. Of these I now remember Staunton, Virginia; Bluefield and Princeton, West Virginia, and Aberdeen, South Dakota. At the last named, they got water in their mains at a pressure of 80 to 100 pounds from artesian wells for several years, but drew so heavily on it that it was finally reduced to zero and for four or five years past have had to resort to pumping. In most localities, water at the tap represents a considerable portion of the expense of the plant, and in these, it seems to me, there can be no sound argument against the use of meters on all services.

I do not think that today there is any doubt as to the advisability of metering all large consumers, such as manufacturing plants. It used to be common practice, especially in the smaller towns which were eager to attract such plants to their locality, to subsidize them at the expense of the water takers, by giving them low flat rates or no rates at all; but this resulted in putting such heavy burdens on the water works that it is not now much in evidence. It is also usually considered advisable to meter buildings used for commercial purposes and for housing more than one or two families, as hotels, flats, tenements, etc., owing partly to the difficulty of assessing equitable flat rates on such premises and partly to the greater waste that usually occurs in them.

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[1] Read at a meeting of the Central States Section at Cleveland, Ohio, October 11, 1916.

The metering of single dwellings of six to ten rooms, with sanitary conveniences—the homes of our average good citizens—is probably least profitable to the water works, as it is in these that the least waste occurs and it is possible to assess a more nearly equitable flat rate on them. But even in these, the few goats amongst the sheep may waste enough to pay for metering of all.

Small houses with one or two spigots are the sore spot in all water works. They are inhabited by a class which cannot pay an average rate and which, when it is deprived of water for non-payment, goes to its neighbor (if he is not metered). Poor building construction, ignorance and bad personal habits, all tend to cause flagrant waste but most superintendents think long before they make up their minds to meter such a locality. When it is realized, however, that ten years' normal supply can be and often is wasted in one collection period, through one service, I believe it will be clear that the meter is the proper remedy, even if it has to be installed at the curb, as is usually the case with this class of services.

To conclude this part of the subject I will quote from the paper on water rates, read at the Rochester convention in 1911, by Geo. G. Earl:

> **The water works system that attempts to work on a flat rate schedule cannot possibly do even approximate justice between its consumers, even those consumers who have the same rates applied to the same fixtures and conditions, because the personal element enters and cannot be eliminated, and the flat rate which averages right for a large number of families will be a rank injustice to the careful consumer, and an equal injustice to the water purveyor in the case of the careless consumer.**

Charging a minimum rate. Consciously or unconsciously, the charging of a minimum rate was the beginning of an effort to make each water taker pay his share of the "overhead;" and the fact that it did not quite accomplish this end is now evidenced by the tendency toward the substitution for it of a "service charge."

The amount of the minimum rate depended, variously, on "what the traffic would bear," on what neighboring towns were charging, on the desire of councils or other governing bodies for re-election and very seldom, on the cost of the service. In Cleveland, where there are several minimum rates in effect, there is one of $5 per annum, which applies to about 80,000 services, or perhaps 75 per cent, and permits the use of 12,500 cubic feet (93,750 gallons) without further charge, about twice as much as the great majority of them use. Another minimum rate of $2.50 per annum was put in effect at the beginning of universal metering, to cover the case of small houses, mentioned above, that paid flat rates of less than $5 per annum. This rate originally applied to about 10,000 services but, on the eve of an election, was extended to apply to about 10,000 more and is now in effect on about 25,000 services. As this rate permits the use of 6,250 cubic feet (46,875 gallons) without further charge, it goes without saying that it is not a profitable rate for the water department.

In general terms, the amount of a service charge depends on the size of the service; what it costs to read and maintain the meter; interest on original cost of meter and service, where these are installed at the cost of the water works; office expense and perhaps some other items.

It should be collected from every service that is capable of being used, whether actually in use or not. Buildings temporarily vacant should not be excepted, though it might be abated in the case of buildings actually destroyed or removed. In the latter case, if the owner had not paid for the installation of the service, and it was to be entirely discontinued, it would be proper to charge him with the original cost less salvage, from which would be deducted the cost of removal. It is perhaps unnecessary to add that the service charge is entirely independent of the charge for water used and would be a fixed amount, probably collected most conveniently annually or semi-annually in advance.

In his paper, quoted above, Mr. Earl says:

> If a certain amount of annual payment is the average that is necessary to pay the interest on the first cost of a certain sized connection and meter, to maintain it in operation and eventually to renew it; to read the meter, keep the accounts and make the collection; then that amount or that amount plus a fair profit is a fair charge for this particular item of service, regardless of whether any water is used through the connection or not, or the amount

of water, or of the character or amount of plumbing inside the premises, or of the uses to which the water is put.

The annual service charge, worked out for New Orleans, from these premises, which included the cost of installation of both meter and service was: ⅝-inch, $4; ¾-inch, $5; 1-inch, $6.50; 1½-inch, $10.50; 2-inch, $14.50; 3-inch, $22; 4-inch, $36; 6-inch, $64; 8-inch, $97. This system gave general satisfaction and on January 1, 1915, the annual service charge was reduced to the followings amounts: ⅝-inch, $3; ¾-inch, $3.60; 1-inch, $4.80; 1½-inch, $7.20; 2-inch, $12; 3-inch, $13.50; 4-inch, $24; 6-inch, $42; 8-inch, $76.

Do water meters increase water bills? This question apparently assumes that consumers, previously paying a flat rate, have meters installed and it can be answered as variously as there are concrete examples of that condition.

Here in Cleveland, about twelve years ago, when operations looking to universal metering had covered about 50 per cent of all services, about 30,000 in all being then metered, I determined that about 93 per cent of those metered had saved money by the operation. That is, about that percentage paid, with meters, only the minimum rate of $5 or $6, then in effect, where they had previously been paying flat rates of $10 to $20 or more.

As the revenue did not decrease in any such proportion, and indeed showed an actual increase, the obvious assumption is that the other 7 per cent more than made up for the loss of revenue from the 93 per cent. It seems to me, therefore, that the only general proposition that can be stated is that, given a flat rate that affords sufficient revenue and is properly adjusted to different classes of consumers, which means that it is high enough to cover all waste, the installation of meters and the fixing of meter rates at a point which will afford a similar revenue, will insure a reduction in rate to all consumers who do not waste water. The usually small numerical proportion of water wasters will, of course, pay more.

It follows that, where flat rates have been too low to afford sufficient revenue, as is the case with some municipal plants partially supported from general taxes, the introduction of meters is likely to cause a horizontal increase if at the same time it is attempted to withdraw the help derived from the tax duplicate; but in any plant which has had a high enough flat rate to make it self-sustaining, it has generally been capable of demonstration that the careful users have been "paying the freight" and the introduction of meters has been the means of shifting the burden to where it belonged.

Testing water meters. The testing of any measuring device is simply a comparison of it with a known standard. In the case of a water meter, this comparison should be made under conditions as nearly approaching those of actual service as possible; which means that water should come to it under average to maximum pressure and should leave it under at least enough back pressure to keep the meter entirely filled with water. For example, it would not be a fair test of a meter to bring the water to it under a 5-foot head nor to discharge it horizontally at the outlet, though most meters as made today, would show some registration even under those conditions and might even register accurately.

In my opinion, all new meters should be tested. A record of this test is often useful, for instance, in disputes over bills. In Cleveland, this test of $\frac{5}{8}$-inch meters was, and I think still is, made with $\frac{1}{2}$-inch and $\frac{1}{16}$-inch orifices at the outlet, by passing 10 cubic feet with the former and 1 cubic foot at the latter or at an approximate rate of 20 cubic feet per minute and 1 cubic foot in ten minutes, respectively. The rate of flow is of course the governing factor and the size of orifice for low-flow tests should be such as will give the desired rate.

I believe that water works engineers now generally recognize that accuracy at extremely low rates of flow can only be obtained at the sacrifice of other essential qualities, such as durability and capacity. For example, it would hardly be considered good practice to weigh coal on jewelers' scales. The commercial test of a meter, therefore, should be one determination at as near the rated capacity of the meter as the pressure at the testing plant will permit and one at the rate of flow of an average leaky faucet or water closet, or say 0.1 cubic foot per minute approximately. While 0.05 cubic foot per minute would not be unreasonable, tests on $\frac{1}{64}$-inch orifices consume much time and in my opinion do not serve any purpose commercially valuable. At some plants, the low flow test is made by merely seeing if the meter works at the low rate, but I believe it is better practice to have a record of a definite amount.

Meters should also be tested for record on being removed from a service and as most old meters do not register at as low a rate of flow as when new, the custom has grown up of testing such meters at different rates of flow, from large to small, until one is reached, at which the meter does not register.

For a small plant with few meters to test, a very satisfactory testing machine can be arranged with a platform scale of 1500 pounds capacity, a 50-gallon barrel, a quick-closing lever valve and an assortment of nozzles, galvanized pipe and fittings. For larger ones, half a dozen good machines, made by as many manufacturers, are on the market. The essential features of such a machine should be convenient devices enabling the quick placing and removal of meters for test; ready graduation of the outlet orifice, pressure gauges, etc. It should have a capacity of four to six meters at one time and it is convenient to be able to run two such lines of meters at the same time, one line being run on full opening and the other at low flow. Percentage beams on the scales are convenient but are difficult of comprehension by the class of labor that usually does meter testing. I found it more satisfactory, in the Cleveland plant, to test by volume, by means of a graduated glass gauge on the side of the tank. Testing by weight can be done with greater accuracy but the error in testing by volume is not large enough to affect the result seriously in a commercial test and this method is more easily comprehended by the average laborer. The tank should have a capacity of 10 cubic feet or 50 gallons, depending on the unit in use, and on machines permitting the running of two lines of meters at once, a second tank of 1 cubic foot or 10 gallons capacity is essential for low-flow tests.

Where there are many large meters to be tested, it is almost essential to have a large tank with a 4 or 6-inch connection, though it is common practice to test 3-inch meters or larger with a 2-inch maximum orifice. Cleveland has a 100 cubic foot tank for this purpose with a maximum orifice of 6 inches and in Baltimore the water department has a 1000 cubic foot tank, on which, as I remember it, 10-inch meters can be tested at full rate.

For testing small meters in service, the best results can be obtained with a measure, which should be sealed by the local authorities having charge of weights and measures. This measure should contain 2 cubic feet or 10 to 20 gallons, depending on the unit in use, and is preferable to a test meter or any testing machine in being easily comprehended by the average small water taker.

For testing large meters in place, it is usually necessary to use a test meter, which should be 1 to 2 inches in size, depending on the size of the meter to be tested. I adopted the method, fifteen years ago, of installing all meters, 2 inches and larger, and in some instances, 1½-inch meters, with valves on both inlet and outlet, and a tap of appropriate size on the outlet side, between the meter and the valve, in which was inserted a nipple, carrying a wheel valve and hose connection. The test meter is connected by hose and another piece of hose is attached to its outlet side to obtain the necessary back pressure. All large meters in service, should be tested at least once a year and where the consumption is very large, perhaps more frequently.

The cost of this form of inspection will be very much more than counterbalanced by being able to correct underregistration due to wear or other causes.